

**EFFECT OF A DENTAL CARE
PROGRAM ON DENTAL HEALTH CONDITIONS**

A study of employees of a Swedish Shipyard

by

GÖRAN SÖDERHOLM

Malmö 1979

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EFFECT OF A DENTAL CARE PROGRAM ON DENTAL HEALTH
CONDITIONS.

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Abstract			
The effect of a <u>dental care program</u> on dental conditions of staff members and workers between 27-66 years old was studied in a Swedish shipyard. The study consisted of two preexperimental periods, 1965-1971 and 1971-1974, compared with an experimental period, 1974-1978. During the later period the employees initially received complete primary preventive and restorative care and were then enrolled in a maintenance program with recalls every third month for <u>preventive care</u> and necessary restoration treatment. Observations were made on: <u>number of teeth, plaque, calculus, overhanging fillings, periodontal bone height, proximal caries, lost teeth and delivered therapy.</u> The results after 3-4 years of maintenance indicate that the combined therapy during the experimental period - improved the standard of oral hygiene - markedly reduced the presence of proximal calculus and overhanging restorations - arrested the progressive loss of periodontal bone previously occurring in the subjects - resulted in a decrease in the number of new carious lesions and in the need of restorations and - decreased the rate of tooth mortality.			
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**EFFECT OF A DENTAL CARE
PROGRAM ON DENTAL HEALTH CONDITIONS**

A study of employees of a Swedish Shipyard

by

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with the co-operation of

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University of Lund, Malmö Sweden, 1979.



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SUMMARY

The effect of a dental care program on dental conditions of 256 staff members and 186 blue-collar workers between 27-66 years old was studied in a Swedish shipyard. The employees initially received complete primary preventive and restorative care and were then enrolled in a maintenance program with recalls every third month for preventive care and necessary restorative treatment.

The results after 3-4 years of maintenance indicate that the combined therapy during the experimental period

- caused an improved standard of oral hygiene
- markedly reduced the presence of proximal calculus and overhanging restorations
- arrested the progressive loss of periodontal bone previously occurring in the subjects
- resulted in a decrease in the number of new carious lesions and the need of restorations and
- decreased the rate of tooth mortality

The following tentative conclusions can be made from the results of the present study:

- Improved dental health can be achieved by a dental care program with a preventive emphasis provided to individuals under routine dental care.

- The increased time and efforts devoted to the frequent recalls and preventive care are compensated by a decreased need of restorative care.
- The major part of the preventive care can be delivered by dental auxiliaries.

INTRODUCTION

In a recent dental survey of a sample of the Swedish population it was found that the number of remaining teeth per individual decreased in higher age groups and at the age of 55-60 years there were only an average of 11 remaining teeth per individual. It was also found that approximately 30 % of premolars and molars were decayed irrespective of the age of the individual and that the occurrence of periodontal pockets and the loss of periodontal bone increased with age (Håkansson 1978). These findings confirmed similar results from several previous surveys made in Sweden and in other countries (for reviews see Waerhaug 1966 and Håkansson 1978).

In 1965 Hilding Björn (1971) examined 1237 staff members and a sample of 652 workers employed at Kockums shipyard in Malmö, Sweden. Eighteen female staff members were, however, not included in Björns report. He found that 6.0 % of the staff members and 11.6 % of the workers were edentulous. The number of remaining teeth decreased with age. In corresponding age groups the staff members had more remaining teeth and a higher number of restored teeth than the workers. Older individuals had less periodontal bone support than younger individuals. In corresponding age groups staff members had more bone support than blue-collar workers. Björn (1971) concluded that the staff members had somewhat better overall dental

conditions and had received more dental care than the workers but that both groups seemed to be exposed to a gradual deterioration of the dentition with increasing age.

In 1971 Anna-Lisa Björn examined those staff members of the shipyard who participated in the 1965 investigation by Hilding Björn (1971) and still were employed by the factory, in all 662 individuals. She related the change in the dental conditions of the individuals during the 1965-1971 interval to the frequency of dental care of the subjects during this six year period.

She found that individuals who had received dental treatment once a year or more often had only slightly fewer carious lesions and as much proximal calculus as individuals who only had received sporadic dental care. The same amount of periodontal bone loss was observed during the six year period in the yearly and sporadic dental care groups. She concluded that the traditional type of dental care with a restorative approach does not seem to be able to prevent a gradual deterioration of the dentition.

Results of recent experimental studies indicate that dental diseases can be prevented. Studies by Suomi et al. (1971), Ramfjord et al. (1975), Lindhe & Nyman (1975) and Axelsson & Lindhe (1978) have demonstrated that progression of periodontal disease can be arrested.

Significant reductions of caries activity have been achieved in children and adolescents (see Koch 1967, Axelsson et al. 1976, Hamp et al. 1978 among others) and in adults (Axelsson & Lindhe 1978).

Thus, it appears that although methods for prevention of caries and periodontal disease exist, they may be difficult to implement under routine dental care delivery systems.

AIM

The present longitudinal study was performed in a clinic designed for routine dental services in order to study the effect of a dental care program with a preventive emphasis. The study aimed at finding out to what extent the dental care would:

- improve the standard of oral hygiene
- prevent formation of proximal calculus
- reduce the occurrence of overhangs of restorations
- prevent further loss of periodontal bone
- prevent new carious lesions
- reduce tooth mortality
- assess the amounts and different types of delivered therapy.

MATERIAL

Kockums Shipyard

The present study was performed at Kockums Shipyard, Malmö, Sweden. This shipyard has about 5.000 employees (3.500 blue collar workers and 1.500 staff members). During the latest decade the factory has gradually expanded its social services and benefits to the employees. A dental clinic was started in 1973 as a part of this development.

The Dental Clinic at Kockums Shipyard

The results of the previous studies by Björn (1971) and Björn (1974) initiated efforts to give the treatment provided at the dental clinic a preventive emphasis already from the start. Also, it was decided to make attempts at a scientific evaluation of the results. In this respect, however, some compromises had to be made due to the fact that the primary goal of the clinic was to provide convenient dental service to employees of the shipyard.

Employees who had participated in the dental surveys by Björn (1971) and Björn (1974) were given first priority to receive dental care at the clinic. Since the opening of the clinic in 1973, a gradual increase of the facilities has taken place. In August 1979 a total of 2.500 individuals had been given complete initial dental care and participated in the mainten-

ance program. It is expected that all employees of the factory, who would like to utilize the dental clinic, can be taken care of within a few years.

The dental service includes emergency treatment, oral hygiene instruction, periodontal, endodontic, restorative and prosthodontic treatment. Once the initial treatment series is completed, the patients are enrolled in the maintenance program. This program included recalls every 3rd month, and a minimum of one yearly oral examination by a dentist.

In August 1979 the dental clinic was staffed with 3 dentists, 1 receptionist, 1 dental hygienist and 8 dental assistants. All of the dental assistants were trained to function as part time plaquecontrol therapists.

Staff members

In 1973 there were 632 staff members previously examined in 1965 and 1971 and still employed at the shipyard. These individuals were ranked with respect to age. The 70 youngest individuals (born 1934-1946) and every second individual from the remaining group were offered dental examination and dental care. The selection of all younger individuals was done in order to get a sufficient number of subjects in this age group. A total of 347 staff members were offered treatment. The invitation was accepted by 283 individuals

and at the conclusion of this study the program was completed by 256 individuals who were re-examined in 1978 (see Fig. 1). The reasons for rejection of treatment and drop-out are given in tables 1 and 2.

Table 1.

Distribution of untreated staff members and workers according to reason for non-participation.

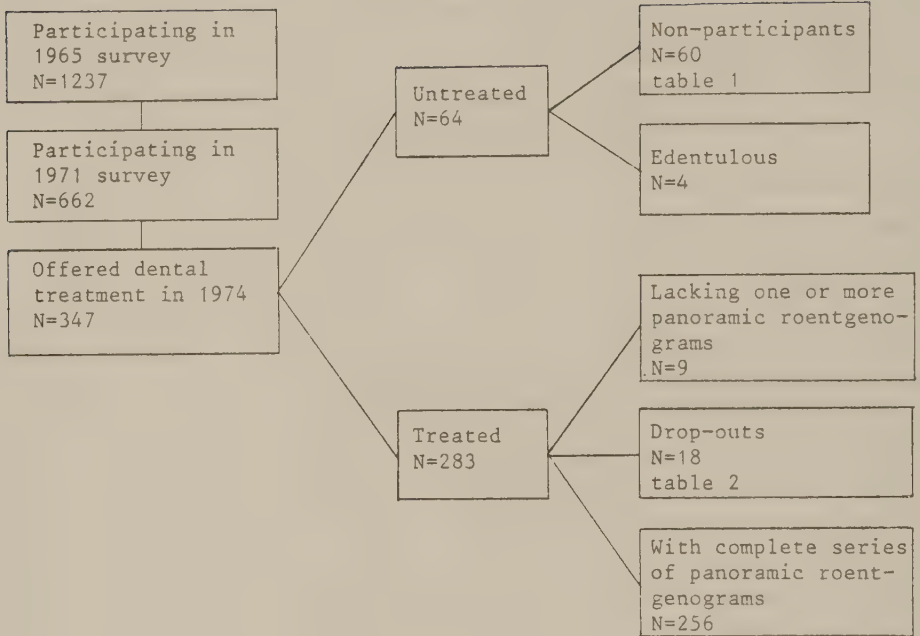
	Staff Members	Workers
Prefer their previous dentist	58	30
Prolonged illness	2	3
Leave of absence		1
No response		4
Total	60	38

Table 2.

Distribution of drop-outs of participants during the 1974-1978 treatment period according to cause of drop-out.

	Staff Members	Workers
Terminated employment at the shipyard	1	8
Deceased	7	3
Prolonged illness	3	6
Discontinued treatment	2	6
Received full dentures	5	20
Total	18	43

Staff members



Workers

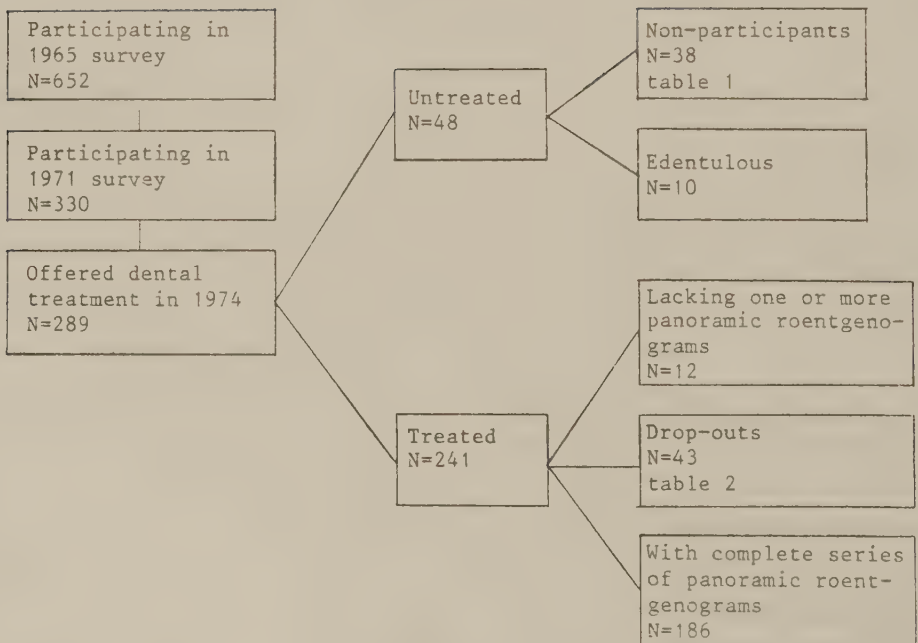


Fig.1. Samples of staff members and workers.

Workers

In 1973 289 blue collar workers who had been examined in 1965 and 1971 were still employed at the shipyard. All these individuals were offered examination and dental care. The invitation was accepted by 241 persons who started treatment. The program was completed by 186 individuals who were re-examined in 1978 (see Fig 1). The reasons for rejection of treatment and drop-out are given in tables 1 and 2.

Age groups

The subjects were divided into three age groups for analyses of plaque, calculus, overhanging restorations, caries and tooth mortality (see table 3). For analyses of alveolar bone height and number of remaining teeth the subjects were divided into eight and nine age groups respectively. In corresponding age groups the workers were two years older than the staff members since they were divided in the same groups as in earlier investigations.

Dental care frequency

The frequency of dental care among staff members and workers before their participation in the shipyard dental program is presented in table 4.

Table 3.

Distribution of participants on age groups.

Staff Members				Workers			
N	Age groups	n	Year of birth	N	Age groups	n	Year of birth
86	I 1	3	1946	64	I 1	10	1943
	2	15	1945-1941		2	30	1942-1938
	3	34	1940-1936		3	24	1937-1933
	4	34	1935-1931	45	II 4	19	1932-1928
85	II 5	36	1930-1926		5	26	1927-1923
	6	49	1925-1921	77	III 6	29	1922-1918
85	III 7	46	1920-1916		7	27	1917-1913
	8	30	1915-1911		8	21	1912-1908
	9	9	1910-1906				
Total		256				186	

Table 4.

Percentages of participants with regular respectively irregular dental care before their participation in the shipyard dental program.

Dental care	Staff Members	Workers
	N= 256	N= 186
Regular	71.5 %	52.7 %
(Once a year or more)		
Irregular	28.5 %	47.3 %
(Less than once a year)		

Untreated group

A total of 60 dentulous staff members and 38 dentulous workers did not participate in the program in 1974 (see table 1). In 1978 these persons were asked to volunteer for an examination. A total of 50 staff members and 34 workers appeared for this examination comprising a panoramic and bitewing roenthenographic examination. These two groups of employees, which had not received treatment at the shipyard clinic ("untreated" subjects), were used for comparisons of occurrence of proximal calculus and overhanging restorations with the treated groups.

In the following text the prefixes "treated" and "untreated" are used in sections where comparisons were made. In the remaining sections treated employees are simply termed "staff members" and "workers".

Observation periods

The individuals were successively taken under treatment. This caused some variation in the length of the 1971-1974 pre-experimental period and the 1974-1978 experimental period (see table 5). The 1974-1978 experimental period included the initial treatment phase and the subsequent maintenance phase. The length of the initial treatment phase varied between the employees, depending upon the need

of initial treatment, from a minimum of two weeks to a maximum of about six months. The length of the 1965-1971 pre-experimental period was for all staff members and workers 6 years with a range of 4 months.

Table 5.

Length in months of the 1971-1974 pre-experimental and the 1974-1978 experimental periods.
Means and standard deviations.

	Staff members			Workers		
	Age group			Age group		
	I	II	III	I	II	III
	N=86	N=85	N=85	N=64	N=45	N=77
1971-1974	42.8 $\pm$ 2.5	39.7 $\pm$ 3.5	35.6 $\pm$ 3.5	32.0 $\pm$ 7.8	29.6 $\pm$ 2.4	28.4 $\pm$ 2.1
1974-1978	38.7 $\pm$ 3.5	42.0 $\pm$ 4.2	46.2 $\pm$ 4.1	47.3 $\pm$ 7.0	49.2 $\pm$ 4.4	50.6 $\pm$ 3.6

METHODS

Dental care

The dental treatment during the experimental period was divided into initial dental care and maintenance care as follows:

Initial dental care

Clinical and roentgenographic examination
Dental health information
Dietary recommendations
Supra- and subgingival debridement and removal of overhangs
Endodontic treatment
Supplementary periodontal treatment
Restorative and prosthodontic treatment

The roentgenographic examination comprised bite-wing roentgenographs and ortopantomograph (Paatero 1960). Dental health information, instruction in oral hygiene, dietary recommendations, removal of overhangs and scaling were carried out by the auxiliaries. This introductory treatment was usually completed in three to four visits. The supplementary periodontal treatment included surgery when periodontal pockets ≥ 6 mm remained after subgingival scaling. The indications for prosthodontic treatment were restrictive.

Maintenance care

Recall visits every 3rd month during the maintenance phase were structured as follows:

Recording of plaque

Recording of periodontal pockets

Oral hygiene evaluation and reinstruction

Debridement (scaling, root planing and polishing)

Roentgenographic examination with bite-wing technique once a year

Topical application of 2,0 % sodium fluoride in caries active patients

The recalls were routinely managed by the auxiliaries. Additional appointments for supplementary periodontal, restorative or other treatment performed by a dentist were scheduled when necessary. All patients were examined by a dentist at least once a year.

Dispensers with 0.05 % sodium fluoride solution for oral rinses were mounted in restrooms and dressing-rooms in the shipyard and thus made available for every employee. The utilization of this facility was evaluated with a questionnaire given to 150 workers and 50 staff members and reported by Söderholm & Petterson (1977). Forty-two % claimed that they utilized the fluoride in the recommended way, 36 % claimed that they rinsed but not in

the recommended way and 22 % did not use fluoride mouthrinses at all.

Clinical parameters

The clinical parameters used in the present study were chosen in order to be as objective as possible and to be reproducible during the observation period from 1965 to 1978. Methods used during the previous dental surveys at the shipyard limited the options. Because of these facts roentgenographic parameters were chosen for proximal calculus, overhanging restorations, periodontal bone height, number of teeth and tooth mortality. Clinical records were used for evaluation of dental plaque and amount and type of delivered therapy.

Data were collected on:

1. Number of remaining teeth
2. Dental plaque
3. Proximal calculus
4. Overhanging restorations
5. Periodontal bone height
6. Proximal caries increment
7. Tooth mortality
8. Delivered therapy

Dental plaque was scored before treatment in 1974 and subsequently every year.

Bite-wing roentgenographs were used for determination of proximal calculus, overhangs and

caries. Bite-wing roentgenographs were available from 1971 (three years before start of treatment at the shipyard clinic) and additional roentgenographic examinations were performed before and after initial treatment in 1974 and once yearly 1975-1978. The films were exposed by dental assistants who had been given a special training program. Long-cone technique and orthoradial projection was used. Four bite-wing roentgenographs were obtained from patients with complete sets of premolars and molars.

Bite-wing films were not available from 27 staff members and 49 workers. This was explained by the fact that premolars and molars were absent in these individuals or that only single teeth were present making bite-wing films superfluous for clinical diagnostic purposes. Most frequently this occurred in the oldest age group (see table 6).

Table 6.

Proportion of participants with bite-wing roentgenographs.

Age group	Staff Members		Workers	
I	86/86	(100 %)	58/64	(91 %)
II	81/85	(95 %)	31/45	(87 %)
III	62/85	(73 %)	40/77	(52 %)
Total	229/256	(89 %)	137/186	(74 %)

Bone height, number of remaining teeth and tooth mortality were assessed from panoramic roentgenographs obtained in 1965, 1971, before treatment in 1974 and at the final examination in 1978.

Number of remaining teeth

The numbers of remaining teeth were determined from the panoramic roentgenographs of 1965, 1971, 1974 and 1978 in 256 staff members and 186 workers. Impacted teeth and root remnants surrounded by bone were not included.

Dental plaque

The teeth were stained with a disclosing solution (Rondell R, Astra, Sweden). The patients then rinsed with water. Presence or absence of clearly stained plaque along the gingival margin was scored on four surfaces of every tooth (buccal, lingual, mesial and distal). The mesial and distal surfaces were inspected from the buccal as well as the lingual aspect. The percentage of surfaces with plaque was calculated for each patient and approximated to the nearest 10 % level (e.g. 23 % was approximated to 20 % and 27 % to 30 %).

The plaque scores were obtained initially as well as at the recall visits by one of the plaque control therapists. If plaque scores in an individual were lacking for an even 12-month interval the nearest three months recall

score was used. If no plaque scores had not been recorded within a three months period of a yearly interval, no score was used for that subject at that particular year. This resulted in some variation of the number of subject with plaque data from the different yearly examinations. All subjects had not reached 4 years of maintenance at the end of the observation period (see tables 7 and 8).

Table 7.

Number of staff members with plaque data at the different yearly examinations.

Age Group	N	1974	1975	1976	1977	1978
I	86	74	72	72	65	20
II	85	83	80	78	76	51
III	85	76	63	64	67	58
Total	256	233	215	214	208	129

Table 8.

Number of workers with yearly plaque data at the different yearly examinations.

Age group	N	1974	1975	1976	1977	1978
I	64	56	47	53	53	47
II	45	43	38	38	43	39
III	77	70	60	59	68	63
Total	186	169	145	150	164	149

In order to evaluate the reproducibility of the plaque scores two studies were done. In the first two independent plaque therapists recorded ten patients under treatment in the dental clinic. Out of the ten inter-individual comparisons seven were concordant and three deviated 10 %.

In the other study three independent plaque control therapists recorded ten patients under treatment in the dental clinic. Each of these patients was examined at the same visit by each of the auxiliaries who changed turns to score the patients. Analysis of the results with respect to the sequence of the recordings demonstrated a decrease of the mean scores amounting to 10 % comparing the first and the third recordings (see table 9). This variation was most likely explained by the fact that some of the stain had disappeared during the examination. Analysis of the results with respect to plaque control therapists showed that out of the total of 30 inter-individual comparisons nine were concordant, 15 deviated 10 % and 6 deviated 20 % (see table 10).

These numbers indicate a satisfactory reproducibility of the plaque scoring method. Whilst deviations of 10 % were often encountered, deviations amounting to 20 % were infrequent.

Table 9.

Reproducibility of plaque score. Three successive recordings (1, 2 and 3) performed by three independant plaque therapists (a, b and c) in 10 patients.

Patient	Sequence of recording		
	1	2	3
1	10 (b)	10 (a)	0 (c)
2	10 (c)	20 (a)	10 (b)
3	40 (b)	40 (a)	20 (c)
4	20 (c)	20 (b)	10 (a)
5	50 (a)	40 (c)	40 (b)
6	50 (a)	50 (b)	30 (c)
7	20 (c)	10 (a)	10 (b)
8	20 (b)	10 (c)	20 (a)
9	60 (a)	30 (c)	40 (b)
10	40 (a)	40 (b)	30 (c)
Mean $\pm$ s.d.	32 $\pm$ 18.1	27 $\pm$ 14.9	21 $\pm$ 13.7

Table 10.

Reproducibility of plaque scores. Recordings in 10 patients by three plaque control therapists (a, b and c).

Patient	Therapist		
	a	b	c
1	10	10	0
2	20	10	10
3	40	40	20
4	10	20	20
5	50	40	40
6	50	50	30
7	10	10	20
8	20	20	10
9	60	40	30
10	40	40	30
Mean $\pm$ s.d.	31 $\pm$ 19.1	28 $\pm$ 15.5	21 $\pm$ 12.0

Proximal calculus

The presence of proximal calculus was determined for mesial and distal surfaces of molars and premolars and distal surfaces of canines in bite-wing roentgenographs from 1971, before treatment in 1974 and from the final examination in 1978. The films were examined by one observer, unaware of the year of the films, under 2 x magnification using a roentgenographic viewer. Structures which appeared as distinct, more or less triangular projections from the proximal tooth surfaces were recorded. Overlapping proximal surfaces on the roentgenographs were not scored (see table 11). For each individual and each of the years of observation the percentage of proximal surfaces with calculus was used for the statistics.

Bite-wing roentgenographs from 21 randomly selected individuals, 14 staff members and 7 workers, were used for evaluation of the reproducibility of the calculus readings. The second reading was performed after all bite-wing roentgenographs from all employees had been examined once. The results from the first determination were not available for the observer during the second reading. Concordant readings were obtained in 97.5 % of the instances (see table 12). Only at a few occasions the classification of a surface as overlapped and unreadable did not coincide between the two readings.

Table 11.

Proximal calculus. Means of percentage tooth surfaces
per individual as readable in bite-wing roentgenographs.

	Staff Members			Workers		
	Age group			Age group		
	I	II	III	I	II	III
	N=86	N=81	N=62	N=58	N=39	N=40
1971	85.7	84.5	86.0	85.6	86.4	83.7
1974	88.9	82.8	83.1	83.7	83.7	77.5
1978	92.0	89.9	90.0	92.5	84.5	87.1

Table 12.

Proximal calculus. Reproducibility of readings.

Reading II	Reading I	
	Number of surfaces with calculus	Number of surfaces without calculus
With calculus	336	18
Without calculus	24	1 320

Overhanging restorations

The analysis of the bite-wing roentgenographs to determine overhangs of radiopaque fillings or crowns was performed by one observer using a 7 x magnifying lens and being unaware of the year of the examined films. A scale with 0.1 mm divisions was built into the magnifier (Björn et al. 1969 and Björn 1974). Overhangs with a satisfactory projection in the horizontal dimension were scored and classified in two groups: overhangs ≥ 0.2 mm and overhangs ≥ 0.4 mm. An individual surface could thus be scored as

- not filled
- filled without overhang
- filled with overhang ≥ 0.2 mm
- filled with overhang ≥ 0.4 mm
- filled but unreadable with respect to overhangs

Proximal surfaces filled with material not giving contrast on the roentgenographs were considered unreadable. Proximal surfaces of molars and premolars and distal surfaces of canines were recorded.

The mean percentages of filled proximal surfaces per individual are presented in table 13 and the percentages of filled proximal surfaces readable with respect to overhanging restorations are presented in table 14. In each individual the percentage of surfaces with overhangs ≥ 0.2 mm and ≥ 0.4 mm was calculated for each year of observation.

Table 13.

Filled proximal surfaces. Means of percentage tooth surfaces per individual as recorded from roentgenographs.

	Staff Members			Workers		
	Age group			Age group		
	I	II	III	I	II	III
	N=86	N=81	N=62	N=58	N=39	N=40
1971	48.4	52.8	60.1	47.8	43.7	49.0
1974	53.6	54.9	61.6	52.2	50.8	53.3
1978	57.0	57.9	65.0	57.7	56.1	58.9

Table 14.

Overhanging restorations. Means of percentage roentgenographically readable tooth surfaces per individual relative to total numbers of filled surfaces.

	Staff Members			Workers		
	Age group			Age group		
	I	II	III	I	II	III
	N=86	N=81	N=62	N=58	N=39	N=40
1971	70.8	79.0	82.6	84.6	79.5	80.4
1974	74.6	78.2	79.1	83.4	75.6	70.5
1978	81.8	90.4	89.3	93.1	85.9	84.7

Duplicate readings were performed in bite-wing roentgenographs from 21 randomly selected individuals (see under proximal calculus). The percentage of concordant readings was 97.1 % (see table 15).

Table 15.

Overhanging restorations. Reproducibility of readings.
Number of surfaces.

Reading II	Reading I		
	Overhang ≥ 0.4 mm	Overhang ≥ 0.2 mm < 0.4 mm	No overhang
≥ 0.4 mm	32	3	0
≥ 0.2 mm - < 0.4 mm	6	23	6
No overhang	1	7	709

Periodontal bone height

Panoramic roentgenographs from 1965, 1971, 1974 and 1978 were used to assess the periodontal bone height, adjacent to mesial and distal surfaces of mandibular premolars and molars. Björn, Björn & Halling (1975) described an abbreviated bone height index and showed a close correlation between the bone height of mandibular premolars and molars and the bone height of the full dentition.

A 10-grade transparent measuring scale was used for the assessments (Björn 1974). The number of scale divisions corresponding to the part of the teeth not supported by bone was recorded as bone score. All determinations were made by one observer unaware of the year of the roentgenographs. Mean scores per subject were calculated for the different examination years.

Duplicate readings were performed at three different occasions namely in the beginning, in the middle and at the end of the reading period. A total of 74 randomly selected orthopantomographs were used for these readings (see table 16).

A complete 1965-1978 series of panoramic roentgenographs was not available for nine staff members and 12 workers. Thirteen staff members and 16 workers either had no mandibular molars and premolars or displayed orthopantomographs which were unreadable with respect to bone height. This left 243 staff members and 170 workers for the bone height analysis (see Fig 1).

Table 16.

Duplicate readings of periodontal bone height in the beginning (A), in the middle (B) and at the end (C) of the reading period. Number and percentage of surfaces with concordant and discordant readings.

	Duplicate reading		
	A N=25	B N=29	C N=20
Reproducibility			
Concordant	239 (93.4 %)	367 (94.6 %)	255 (95.1 %)
Discordant			
± 1 scale division	14 (5.5 %)	19 (4.9 %)	10 (3.7 %)
Discordant			
± 2 scale divisions	0 (0 %)	0 (0 %)	2 (0.7 %)
Classified as unreadable at the second reading	3 (1.2 %)	2 (0.5 %)	1 (0.4 %)
Total number of surfaces	256	388	268

Table 17.

Proximal caries. Means of percentages tooth surfaces per individual as readable in bite-wing roentgenographs.

	Staff Members			Workers		
	Age group			Age group		
	I N=86	II N=81	III N=62	I N=58	II N=39	III N=40
1974	93.2	89.7	90.5	90.7	96.0	86.1
1978	87.6	89.2	91.7	89.3	90.7	90.0

Proximal caries increment

The presence of caries was determined from bite-wing roentgenographs from 1971, 1974 and yearly films 1975-1978. The analyses were performed in the same individuals as for the analyses of proximal calculus and overhanging restorations (see table 6). Carious lesions which had developed during the 1971-1974 pre-experimental period and during the 1974-1978 maintenance period were recorded in each individual by comparing the available bite-wing films. All caries determinations were performed by one observer using a roentgenographic viewer with 2 x magnification.

Radiolucent zones in the proximal surfaces clearly different from the normal radiographic structure of the tooth substance were classified into primary caries (previously intact surfaces) and secondary caries (adjacent to restorations). The number of proximal surfaces with restorations in 1974 but without restorations in 1971 were included in the 1971-1974 caries data as primary caries. Caries increment during the pre-experimental and maintenance periods was evaluated on teeth present in 1974 and in 1978 respectively.

The mean percentages of readable surfaces with respect to caries are presented in table 17. Bite-wing films from 35 randomly selected individuals were used for the determination of the reproducibility of the caries assessments. Concordant determination of carious lesions occurred in 83.8 % of the readings (see table 18).

Table 18.

Proximal caries. Reproducibility of roentgenographic assessments.

	Reading I	
	Number of surfaces with caries	Number of surfaces without caries
Reading II		
With caries	88	9
Without caries	8	4 101

Tooth mortality

The numbers of teeth lost during the 1965-1971 and 1971-1974 pre-experimental periods and during the 1974-1978 experimental period were also determined from the panoramic roentgenographs.

Delivered therapy

The delivered therapy was classified as therapy given during the initial treatment phase and therapy given during the maintenance phase. The therapeutic details were taken from the treatment records.

1. Preventive care

The numbers of visits for preventive care were summed up. Preventive care included instruction in oral hygiene, scaling and root

planing, removal of overhangs and topical application of fluorides. One or more of these procedures could be performed at each visit which lasted 15-45 minutes.

2. Periodontal surgery

Regardless of the extent each operation was counted as one procedure. The extent of an operation could vary from a local incision around one single tooth to a full quadrant surgery.

3. Amalgam and composite restorations

Each restoration was counted as one unit irrespective of the number of tooth surfaces involved.

4. Endodontically treated teeth

Every treated tooth was counted as one unit irrespective of the number of visits required.

5. Full crown restorations

No distinction was made between gold-, porcelain- and amalgam full crowns.

6. Fixed bridges

Each fixed bridge was counted as one unit irrespective of the extent of the bridge.

7. Tooth extraction

The indication for extraction was recorded for each extracted tooth and assigned to one of eight different categories.

8. Removable partial and full dentures

Each removable denture was counted as one unit.

Statistical methods

The frequency distribution of numbers of teeth as well as numbers of individuals with different levels of plaque, calculus, caries, and overhang scores often departed considerably from the normal distribution. Examples are given in figures 7 and 8. In many cases there were also significant differences between variances. For these reasons parametric statistical calculations were used only to make possible comparisons with previously reported findings as well as for illustrative purposes. For statistical analysis only non-parametric methods were applied.

The fact that the sampling unit was not teeth or tooth surfaces but the individual has called for caution at the statistical handling of the data. Throughout this investigation observations based on roentgenographs were made on the same number of teeth or tooth surfaces in each separate individual. For all dental

parameters except the numbers of lost/remaining and carious teeth the statistical treatment started with computation of the arithmetic mean per individual. The means obtained were the data used for statistical analysis.

Frequencies as well as frequency distributions were compared by means of chi-square tests. No correction for continuity was applied. Medians were compared with Wilcoxon's matched-pairs signed-ranks test.

In the tables $p < 0.001$ is indicated with *** $p < 0.01$ with ** and $p < 0.05$ with *. Non-significant differences are indicated with N.S.

RESULTS

Number of remaining teeth

For illustrative purposes the means of remaining teeth were subjected to a calculation of the regression on age (see Fig. 2). This figure suggests a decreasing number of remaining teeth with increasing age. Also it indicates a gradual loss of teeth between 1965 and 1974 and an insignificant loss of teeth between 1974 and 1978.

The mean and standard deviation of remaining teeth for each age group of staff members and workers are presented in tables 19 and 20.

Mean numbers of proximal surfaces of molars, premolars and distal surfaces of canines in 1971, 1974 and 1978 are presented in table 21.

Table 21.

Mean numbers of proximal surfaces in molars, premolars and distal surfaces of canines.

Staff Members				Workers		
Age group				Age group		
I	II	III		I	II	III
N=86	N=81	N=62		N=58	N=39	N=40
1971	35.5	31.1	26.0	34.1	26.9	23.5
1974	35.1	30.7	25.3	33.9	26.4	23.2
1978	34.8	30.1	24.2	33.1	26.0	22.6

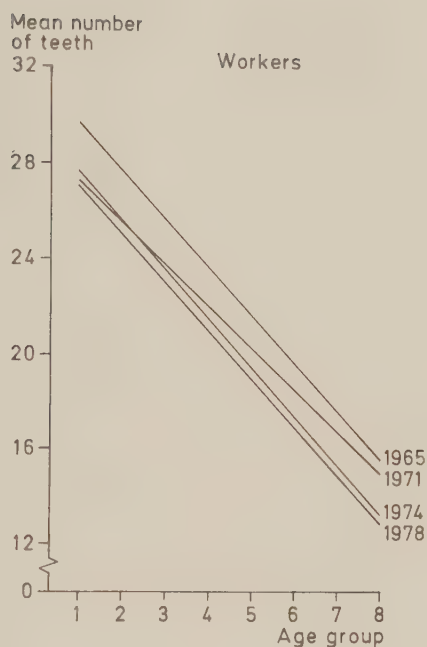
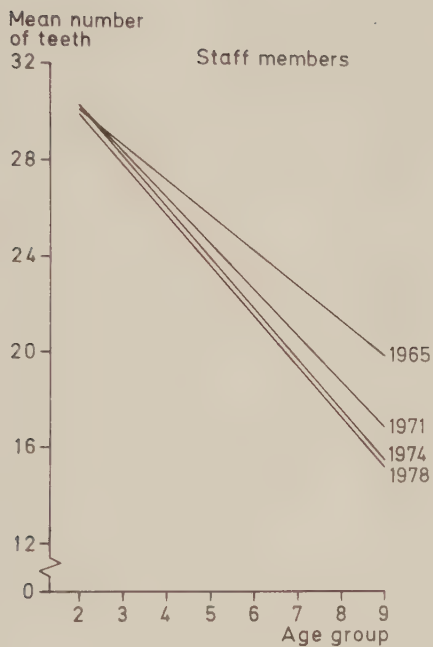


Fig.2. Remaining teeth in participants. Regression of mean numbers on age.

Table 19.

Number of teeth. Staff members. Mean $\pm$ standard deviation.

Age groups

	1-2	3	4	5	6	7	8	9	Total
N	18	34	34	36	49	40	30	9	256
1965	30.1 $\pm$ 1.98	28.8 $\pm$ 1.67	26.9 $\pm$ 3.72	25.6 $\pm$ 4.12	25.4 $\pm$ 4.52	22.3 $\pm$ 5.51	20.1 $\pm$ 5.94	20.8 $\pm$ 7.03	25.1 $\pm$ 5.34
1971	29.1 $\pm$ 2.12	28.3 $\pm$ 1.95	26.6 $\pm$ 3.69	24.9 $\pm$ 4.06	24.5 $\pm$ 5.18	21.5 $\pm$ 5.60	18.6 $\pm$ 6.48	15.4 $\pm$ 7.88	24.1 $\pm$ 5.88
1974	28.9 $\pm$ 2.06	28.0 $\pm$ 1.97	26.3 $\pm$ 3.64	24.6 $\pm$ 4.06	24.1 $\pm$ 5.31	20.4 $\pm$ 5.66	17.2 $\pm$ 7.34	13.9 $\pm$ 8.74	23.5 $\pm$ 6.31
1978	28.4 $\pm$ 1.91	27.8 $\pm$ 1.89	26.0 $\pm$ 3.60	24.3 $\pm$ 4.37	23.6 $\pm$ 5.53	19.9 $\pm$ 5.75	17.1 $\pm$ 7.28	13.6 $\pm$ 8.57	23.1 $\pm$ 6.36

Table 20.

Number of teeth. Workers. Mean + standard deviation.

		Age groups								Total
		1	2	3	4	5	6	7	8	
N	10	30	24	19	26	29	27	21	186	
1965	30.6+1.58	27.3+4.42	24.8+4.56	22.2+6.00	20.9+6.05	19.6+5.58	17.0+6.81	17.5+7.93	21.9+6.99	
1971	30.0+2.06	25.3+6.12	23.3+6.60	21.3+6.03	20.2+6.60	18.1+5.89	15.7+7.32	16.3+7.95	20.6+7.51	
1974	29.4+1.84	24.9+6.06	22.5+7.37	20.6+6.59	19.5+7.08	16.8+6.02	14.4+7.78	15.1+8.18	19.8+7.96	
1978	29.1+1.85	24.7+6.00	22.3+7.20	20.4+6.54	19.3+7.19	16.2+6.33	14.0+8.10	14.8+8.30	19.4+8.08	

Dental plaque

The mean plaque scores before and throughout the maintenance period are presented in fig 3. A reduction of the mean scores occurred after primary treatment. The reduced plaque scores were maintained during the four years of observation.

The distribution of the percentage of individuals with different plaque score levels is presented in Figs 4 and 5. These data served as the basis for the statistical analysis.

Before treatment only 13.7 % of the staff members and 10.7 % of the workers had plaque scores ≤ 20 %. During the maintenance phase 67.4 - 76.4 % of staff members and 44.1 - 61.5 % of workers had reached ≤ 20 % plaque scores. These improvements were statistically significant ($p < 0.001$) at all maintenance intervals for staff members as well as for workers (see table 22).

A comparison between staff members and workers showed no significant difference in number of individuals with plaque scores ≤ 20 % before treatment. However, 'at all intervals during the maintenance phase significantly more staff members than workers reached the ≤ 20 % level (see table 22).

Among the staff members significantly more individuals in the youngest group had reached

the $\leq 20\%$ plaque score level after one year than in the two older age groups. However, the older groups showed a gradual improvement. Among the workers there were no significant differences between the age groups (see table 23).

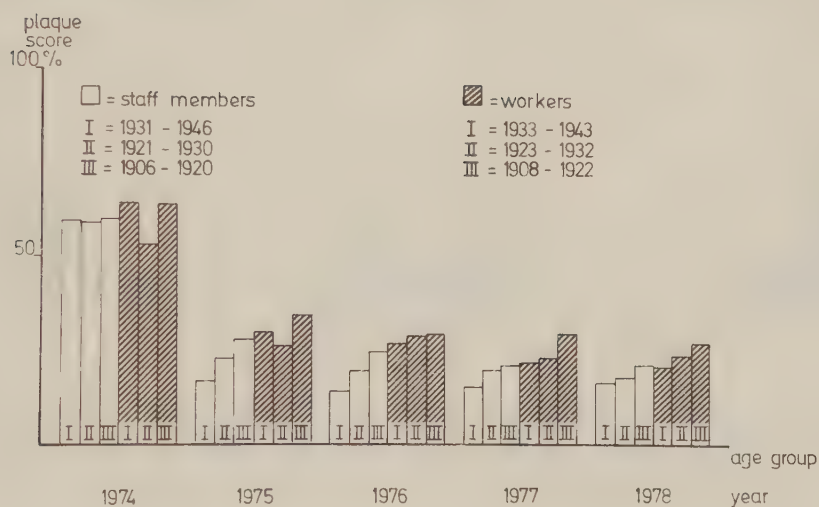


Fig.3. Mean plaque scores for participants in different age groups (I,II,III) before treatment (1974) and throughout the experimental period.

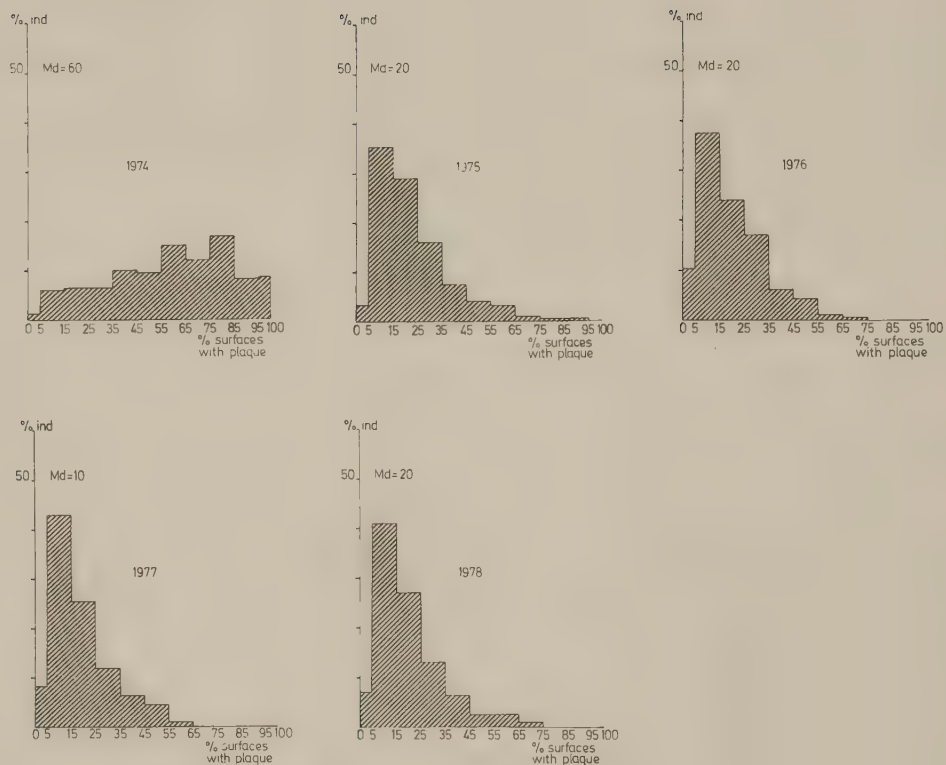


Fig.4. Distribution of percentage staff members on different plaque scores before treatment (1974) and throughout the experimental period (Md=median class).

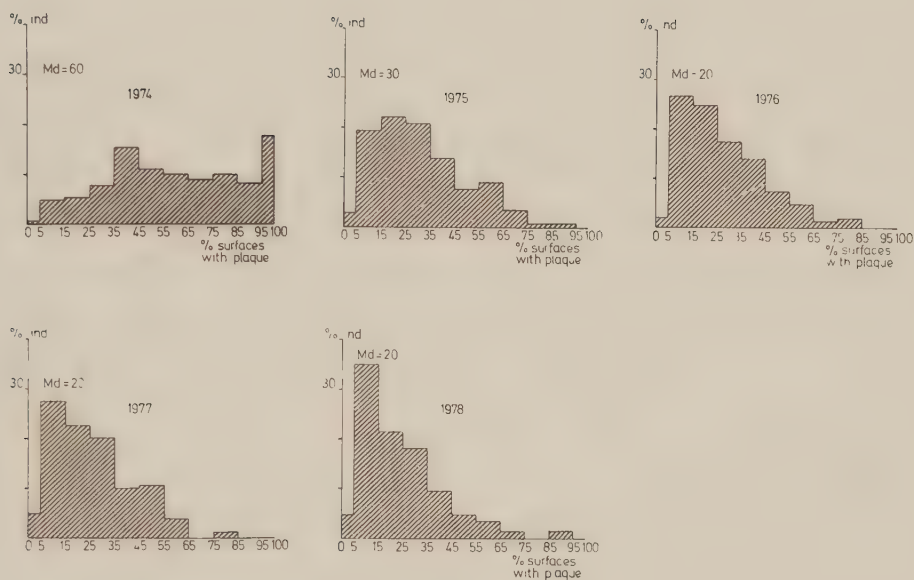


Fig.5. Distribution of percentage workers on different plaque scores before treatment (1974) and throughout the experimental period (Md=median class).

Table 22.

Percentages of participants with plaque scores ≤ 20 %.
Level of significance of differences denoted by asterisks.

	Staff Members		Workers		
	N	%	N	%	
1974	233	13.7	169	10.7	N.S.
1975	215	67.4	145	44.1	***
1976	214	71.5	150	53.3	***
1977	208	76.4	164	54.9	***
1978	129	75.2	149	61.7	*

Table 23.

Percentages of participants with plaque scores ≤ 20 %.
Level of significance of differences denoted by asterisks.

	Staff Members						Workers					
	Age groups						Age groups					
	I		II		III		I		II		III	
	N	%	N	%	N	%	N	%	N	%	N	%
1974	74	8.1	83	16.9	76	15.8	56	12.5	43	4.7	70	12.9
1975	72	86.1	80	65.0	63	49.2	47	40.4	38	55.3	60	40.0
	 * *											

1976	72	81.9	78	71.8	64	59.4	53	54.7	38	52.6	59	52.5
	 **											
1977	65	86.2	76	73.7	67	70.1	53	62.3	43	55.8	68	48.5
	 *											
1978	20	90.0	51	78.4	58	67.2	47	66.0	38	65.8	63	55.6
	 *											

Proximal calculus

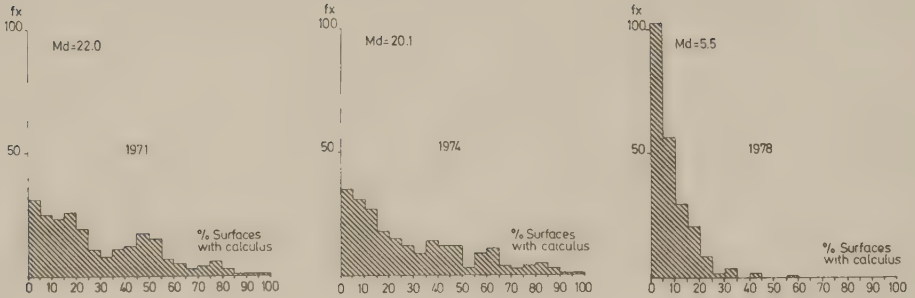
The means of percentages per individual of proximal surfaces with calculus are presented in table 24. The means for treated staff members and workers ranged from 25.9 - 28.6 % in 1971 and 1974 as compared to 6.3 - 7.5 % in 1978. Within the untreated groups the corresponding means were about the same in 1971 and 1978.

The distribution of treated staff members and workers with different percentage levels of calculus is presented in Fig 6.

In 1971 24.5 % of the staff members and 26.3 % of the workers had <10 % surfaces with calculus. In 1974 the percentages were 28.8 % and 27.0 % respectively and did not differ significantly from the values of 1971. In 1978 significantly more treated staff members and workers had <10 % surfaces with calculus, 69.9 % and 76.6 % respectively (see table 25).

The percentages of untreated subjects with <10 % surfaces with calculus were not significantly different from the treated subjects in 1971. The 1978 figures for the untreated subjects were not different from the 1971 values (see table 25).

Staff members



Workers

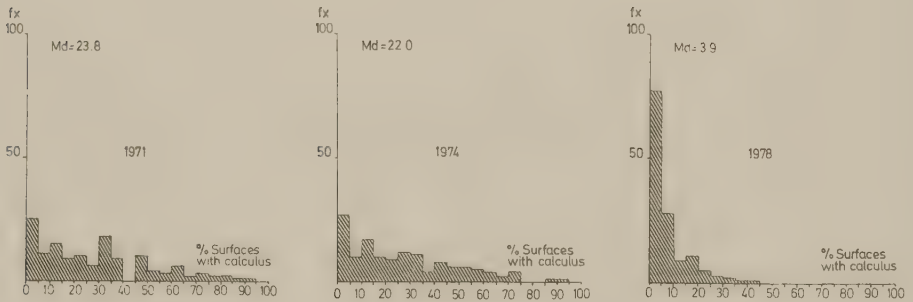


Fig.6. Distribution of treated staff members (N=229) and workers (N=137) on different percentage levels of proximal surfaces with calculus before (1971 and 1974) and at the end (1978) of the experimental period (fx=number of individuals, Md=median).

Table 24.

Proximal surfaces with calculus. Means of percentages
per individual.

	Staff Members		Workers	
	Treated N=229	Untreated N=46	Treated N=137	Untreated N=28
1971	28.3	42.6	28.6	27.3
1974	27.8	x)	25.9	x)
1978	7.5	46.4	6.3	30.2

x) Bite-wing roentgenographs not available.

Table 25.

Percentages of participants with <10 % proximal surfaces
with calculus. Level of significance of differences denoted
by asterisks.

	Staff Members		Workers	
	Treated N=229	Untreated N=46	Treated N=137	Untreated N=28
1971	24.5 N.S.	13.0	26.3 N.S.	25.0
	N.S.		N.S.	
1974	28.8	N.S.	27.0	N.S.
	***		***	
1978	69.9 ***	10.9	76.6 ***	25.0

There was generally less calculus in younger than in older age groups. The differences were statistically significant, however, only in some instances (see table 26).

Table 26.

Percentages of participants with < 10 % proximal surfaces with calculus. Level of significance of differences denoted by asterisks.

	Staff Members			Workers		
	Age groups			Age groups		
	I	II	III	I	II	III
	N=86	N=81	N=62	N=58	N=39	N=40
1971	33.7	19.8	16.1	34.5	30.8	10.0
	-----				-----	
	-----*				-----**	
	-----*				-----**	
1974	30.2	30.9	24.2	31.0	30.8	17.5
1978	77.9	61.7	69.4	75.9	87.2	67.5
	-----				-----	
	-----*				-----*	

Overhanging restorations

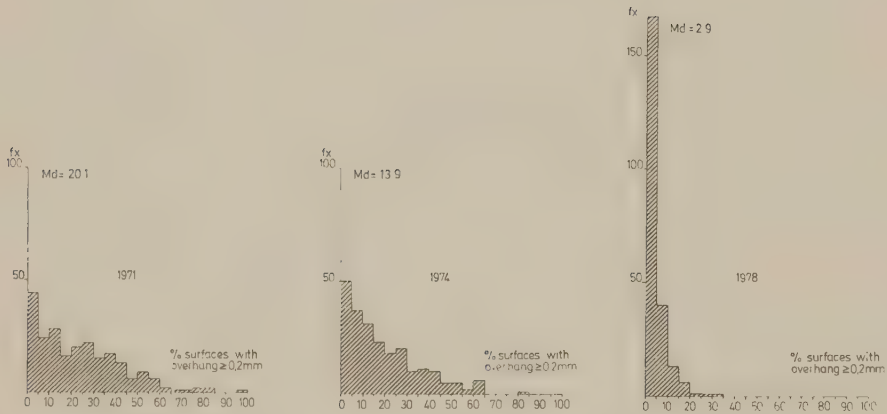
The mean percentages of proximal surfaces with overhanging restorations are presented in table 27. In 1971 treated staff members and workers had means of 21.7 % and 22.8 % for overhangs ≥ 0.2 mm. The corresponding figures before treatment in 1974 were 17.2 % and 17.6 % and the 1978 figures were reduced to 2.9 % and 2.9 % respectively.

The distribution of the numbers of staff members and workers on different percentage levels of overhangs ≥ 0.2 mm and overhangs ≥ 0.4 mm is presented in Figs 7 and 8.

In 1971 19.2 % of the staff members and 20.4 % of the workers had < 5 % proximal restorations with ≥ 0.2 mm overhangs. In 1974 the corresponding figures were 21.8 % and 35.8 % and in 1978 the figures for the treated subjects had increased to 72.9 % and 79.6 % respectively. A corresponding improvement in 1978 was observed for overhangs ≥ 0.4 mm (see table 28).

In the untreated staff members and workers there were no significant differences with respect to overhangs ≥ 0.2 mm between 1971 and 1978. In 1978 statistically significant ($p < 0.001$) differences between the treated and untreated groups were observed (see table 28).

Staff members



Workers

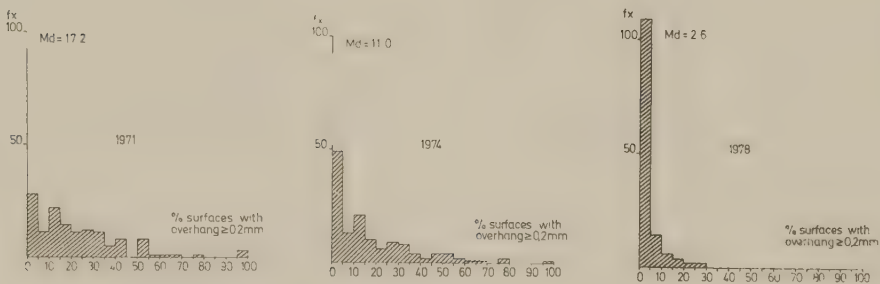
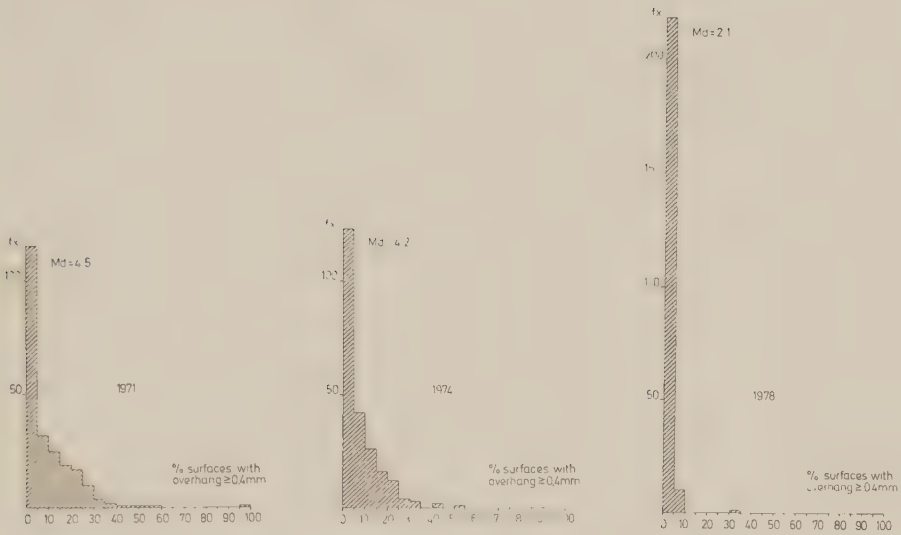


Fig.7. Distribution of treated staff members (N=229) and workers (N=137) on different percentage levels of proximal surfaces with overhangs ≥ 0.2 mm before (1971 and 1974) and at the end (1978) of the experimental period (fx=number of individuals, Md=median).

Staff members



Workers



Fig.8. Distribution of treated staff members (N=229) and workers (N=137) on different percentage levels of proximal surfaces with overhangs >0.4 mm before (1971 and 1974) and at the end (1978) of the experimental period (fx=number of individuals, Md=median).

Table 27.

Proximal surfaces with overhanging restorations ≥ 0.2 mm and ≥ 0.4 mm. Means of percentages per individual.

	Staff Members				Workers			
	Treated N=229		Untreated N=46		Treated N=137		Untreated N=28	
	≥ 0.2	≥ 0.4	≥ 0.2	≥ 0.4	≥ 0.2	≥ 0.4	≥ 0.2	≥ 0.4
1971	21.7	9.5	25.8	9.8	22.8	8.1	18.6	7.3
1974	17.2	6.1	x)	x)	17.6	6.0	x)	x)
1978	2.9	0.5	17.7	4.5	2.9	0.1	11.4	3.5

x) Bite-wing roentgenographs not available.

Table 28.

Percentages of participants with $< 5\%$ proximal restorations with overhangs ≥ 0.2 mm and ≥ 0.4 mm. Level of significance of differences denoted by asterisks.

	Staff Members			Workers		
	Treated N=229		Untreated N=46	Treated N=137		Untreated N=28
	≥ 0.2	≥ 0.4	≥ 0.2	≥ 0.2	≥ 0.4	≥ 0.2
1971	19.2	50.2	13.0	20.4	57.7	25.0
	N.S.	N.S.			N.S.	
1974	21.8	53.7	N.S.	35.8	67.2	N.S.
	***	***		***	***	
1978	72.9	95.2	26.1	79.6	99.3	35.7
	***			***		

Periodontal bone height

For illustrative purposes the bone scores were subjected to a calculation of the regression on age. Figure nine suggests a decreasing bone height with increasing age and a gradual loss of periodontal bone between 1965 and 1974 for staff members as well as workers. A reversal of the trend to decreased bone height seems to have occurred between 1974 and 1978. Both these trends are confirmed by the changes in median values and the results of Wilcoxon's tests on differences between medians (see tables 29, 30, 31 and 32).

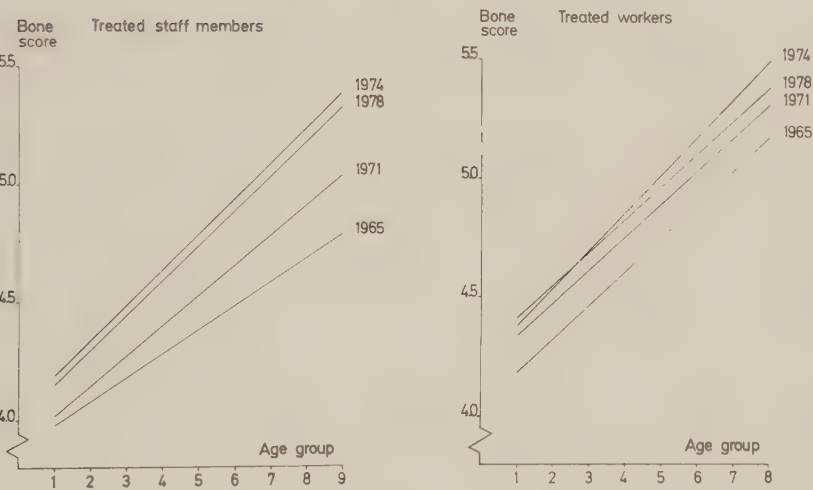


Fig.9. Regression of bone scores on age.

Table 29.

Medians and ranges of mean bone score per staff member.

		Age groups								
		1-2	3	4	5	6	7	8	9	1-9
N		18	33	34	36	47	42	25	8	243
1965										
Md		4.00	4.10	4.20	4.37	4.36	4.72	4.40	4.42	4.25
Range		3.6-4.3	3.8-4.8	3.9-5.3	3.9-6.5	3.8-5.1	4.0-5.9	4.0-5.4	4.0-6.0	3.6-6.5
1971										
Md		4.00	4.25	4.27	4.50	4.50	5.00	4.75	4.87	4.40
Range		3.7-4.4	4.0-5.2	4.0-5.3	4.0-6.5	3.8-6.0	4.0-6.6	4.0-5.8	4.3-7.0	3.7-7.0
1974										
Md		4.34	4.46	4.44	4.75	4.70	5.23	5.00	5.50	4.71
Range		4.0-4.8	4.0-5.0	4.0-5.4	4.3-7.0	4.1-6.0	4.0-7.1	4.1-6.2	4.3-8.0	4.0-8.0
1978										
Md		4.23	4.36	4.37	4.83	4.80	5.00	5.00	5.17	4.67
Range		3.9-5.1	4.0-5.1	4.0-5.0	4.1-7.5	4.0-7.0	4.0-6.9	4.0-6.3	4.3-7.0	3.9-7.0

Table 30.

Medians and ranges of the mean bone score per worker.

		Age groups									
		1	2	3	4	5	6	7	8	1-9	
N		10	29	21	19	25	27	21	18	170	
1965											
Md		4.14	4.36	4.50	4.50	4.56	5.00	4.86	5.10	4.60	
Range		4.0-4.6	4.0-5.1	4.0-5.2	4.0-5.1	4.0-7.3	4.1-6.5	4.0-6.5	4.6-7.0	4.0-7.3	
1971											
Md		4.29	4.40	4.69	5.00	4.63	5.08	4.86	5.18	4.74	
Range		4.0-4.7	4.0-5.4	4.0-5.5	4.0-5.4	4.0-6.0	4.1-6.5	4.0-6.0	4.4-8.0	4.0-8.0	
1974											
Md		4.24	4.50	4.77	4.90	4.75	5.20	5.00	5.30	4.86	
Range		4.0-4.9	4.0-5.4	4.0-6.0	4.3-5.5	4.1-6.1	4.2-7.0	4.3-6.5	4.4-8.5	4.0-8.5	
1978											
Md		4.23	4.46	4.67	5.00	4.71	5.22	5.00	5.06	4.86	
Range		4.0-4.7	4.0-5.3	4.0-7.0	4.0-5.4	4.1-6.2	4.3-7.0	4.0-6.0	4.2-8.0	4.0-8.0	

Table 31.

Wilcoxon's tests on differences between median bone-score values. Staff members.
N = number of signed ranks.

Periods	Age groups								
	1+2	3	4	5	6	7	8	9	1-9
1965-71									
N	8	22	18	25	32	27	15	5	152
Smaller sum of ranks	0.0	0.0	14.5	42.0	42.5	31.0	0.0	0.0	713
Level of significance	**	***	***	***	***	***	***	*	***
1971-74									
N	15	26	30	33	36	30	23	6	199
Smaller sum of ranks	0.0	26.0	6.0	23.5	28.0	37.5	6.0	0.0	776
Level of significance	***	***	***	***	***	***	***	*	***
1974-78									
N	13	24	24	27	37	28	16	4	173
Smaller sum of ranks	(-)21	(-)120.5	(-)38.0	185.5	(-)316.5	(-)149.0	(-)45.0	0.0	(-)5121.5
Level of significance	N.S.	N.S.	**	N.S.	N.S.	N.S.	N.S.	N.S.	***

Table 32.

Wilcoxon's tests on differences between median bone score values. Workers.

N = number of signed ranks.

[illegible]

Table 33.

Numbers of new proximal carious lesions (primary + secondary)
developed during the pre-experimental and experimental periods.

	Staff Members N=229			Workers N=137		
	Total number of lesions	Mean per indivi- dual	Mean per year 1)	Total number of lesions	Mean per indivi- dual	Mean per year 1)
1971-1974	289	1.26	0.38	144	1.05	0.42
1974-1978	120	0.52	0.15	107	0.78	0.19

1) The yearly caries increments during the 1974-1978 period are
calculated by dividing the mean number of lesions per individual
with the mean length of the total experimental period which in-
cludes the initial treatment phase.

Proximal caries increment

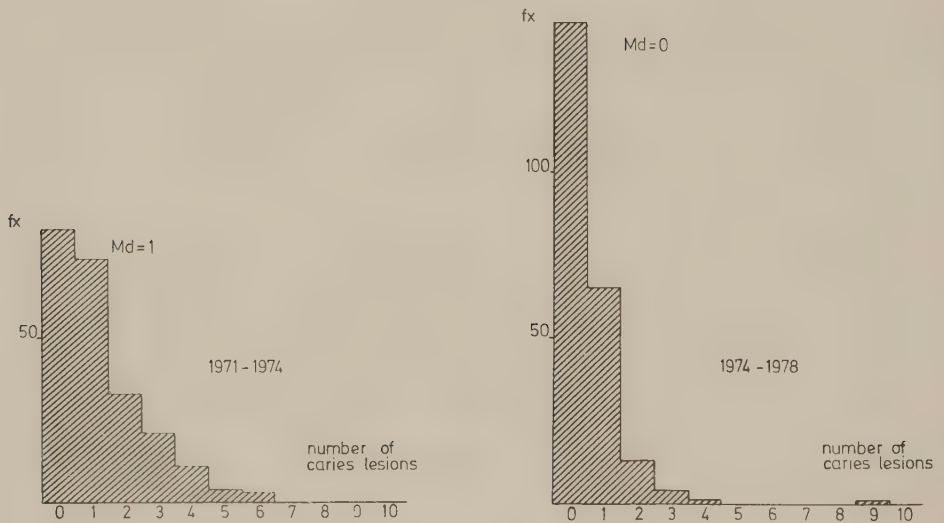
The total numbers and means per individual of new proximal carious lesions in staff members and workers during the pre-experimental and maintenance periods are presented in table 33.

The calculated yearly caries increment during the pre-experimental period was 0.38 and 0.42 lesions for staff members and workers respectively as compared to yearly increments of 0.15 and 0.19 lesions during the maintenance period.

The numbers of staff members and workers with various numbers of carious lesions during the pre-experimental and maintenance periods are shown in Fig 10. More individuals had fewer lesions during the maintenance period than during the pre-experimental period.

The percentages of staff members and workers without primary and secondary carious lesions are presented in table 34. Significantly more individuals were without lesions during the maintenance period than during the pre-experimental period. Among the staff members this difference was statistically significant for each of the three age groups. Among the workers only the middle age group reached a significant difference (see table 35).

Staff members



Workers

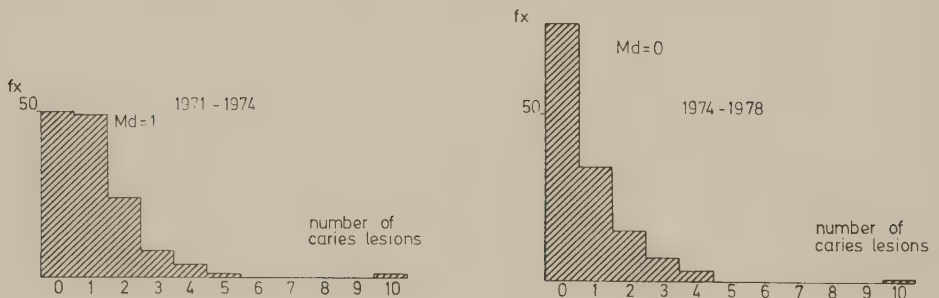


Fig.10. Distribution of staff members (N=229) and workers (N=137) on number of primary+secondary proximal carious lesions during pre-experimental (1971-1974) and experimental periods (fx=number of individuals, Md=median).

Table 34.

Percentages of participants without proximal carious lesions during the pre-experimental and experimental periods. Levels of significance of differences denoted by asterisks.

	Staff Members		Workers
	N=229		N=137
<u>Primary caries</u>			
1971-1974	65.9	N.S.	58.4
	***		***
1974-1978	84.7	N.S.	81.0
<u>Secondary caries</u>			
1971-1974	57.2	N.S.	66.4
	***		N.S.
1974-1978	75.5	N.S.	68.6
<u>Primary + secondary caries</u>			
1971-1974	36.2	N.S.	36.5
	***		**
1974-1978	63.3	**	56.2

Table 35.

Percentages of participants without proximal carious lesions (primary + secondary) during the pre-experimental and experimental periods. Levels of significance of differences denoted by asterisks.

	Staff Members			Workers		
	Age groups			Age groups		
	I	II	III	I	II	III
	N=86	N=81	N=62	N=58	N=39	N=40
1971-1974	30.2	37.0	43.5	34.5	33.3	42.5
	**	***	*	N.S.	*	N.S.
1974-1978	54.7	70.4	66.1	51.7	56.4	62.5

Tooth mortality

The numbers of staff members and workers with varying numbers of teeth lost during the 1965-1971 and 1971-1974 pre-experimental periods and during the 1974-1978 experimental period are demonstrated in Fig 11. The percentages of individuals without tooth loss during the same periods are presented in tables 36 and 37. Significantly more individuals without tooth loss were found during the 1974-1978 period than during the 1971-1974 period for the oldest age groups, 76.5 % and 75.3 % for staff members and workers respectively during the experimental period as compared to 48.2 % and 50.6 % during the pre-experimental period.

The number of lost teeth was approximately twice as high during the 1971-1974 pre-experimental period compared to the 1974-1978 experimental period (see table 38). The loss of wisdom teeth in relation to other tooth types was significantly higher during the 1974-1978 experimental period than during the 1971-1974 pre-experimental period for staff members as well as workers (see table 38).

Staff members



Workers

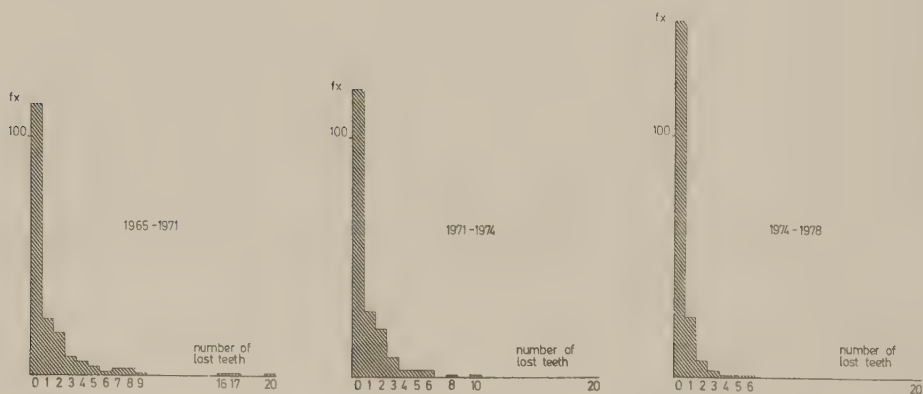


Fig.11. Distribution of staff members (N=229) and workers (N=137) on number of teeth lost during the pre-experimental (1965-1971;1971-1974) and experimental periods (fx=number of individuals).

Table 36.

Percentages of participants without tooth loss during the pre-experimental and experimental periods. Levels of significance of differences denoted by asteriscs.

	Staff Members N=256	Workers N=186
1965 - 1971	59.0 N.S.	61.3 N.S.
1971 - 1974	66.4 *	64.5 ***
1974 - 1978	76.6	79.6

Table 37.

Percentages of participants without tooth loss during the pre-experimental and experimental periods. Levels of significance of differences denoted by asteriscs.

	Staff Members			Workers		
	Age groups			Age groups		
	I N=86	II N=85	III N=85	I N=64	II N=45	III N=77
1965 - 1971	63.9 *	65.8 N.S.	45.9 N.S.	62.5 N.S.	66.7 N.S.	57.1 N.S.
1971 - 1974	79.1 N.S.	71.8 N.S.	48.2 ***	70.3 N.S.	80.0 N.S.	50.6 ***
1974 - 1978	79.1	74.1	76.5	84.4	80.0	75.3

Table 38.

Percentage distribution of different types of lost teeth during the pre-experimental and experimental periods. Level of significance of differences denoted by asterisks.

Staff Members (N=256)						
	Total number of lost teeth	Wisdom teeth	Molars	Premo- lars	Cani- nes	Inci- sors
1965-1971	254	26.8	29.5	19.7	5.1	18.9
1971-1974	162	24.1	30.9	27.8	4.9	12.3
		*				
1974-1978	94	37.2	27.7	22.3	2.1	10.6
Workers (N=186)						
	Total number of lost teeth	Wisdom teeth	Molars	Premo- lars	Cani- nes	Inci- sors
1965-1971	247	8.1	30.8	28.7	8.9	23.5
1971-1974	154	11.0	26.6	27.3	4.5	30.5
		**				
1974-1978	63	28.6	15.9	19.0	3.2	33.3

Delivered therapy

The means of the number per individual of the different procedures during the initial treatment phase and during the maintenance phase are presented in table 39.

It can be observed from the table, that for most types of therapy about the same numbers of procedures per individual were carried out for staff members and workers. During the initial treatment phase (2 weeks - 6 months) 5.3 and 4.4 preventive visits were given to staff members and workers respectively as compared to 3.2 visits per year during the maintenance phase. The initial treatment phase required 3.4 and 4.5 amalgam + composite restorations for staff members and workers respectively as compared to 1.2 restorations per year during the maintenance phase.

The indications for extractions during the 1974-1978 experimental period are presented in table 40. The predominant indication for extraction was periodontitis, 31.9 % for staff members and 22.2 % for workers respectively, or a combination of periodontitis with caries or endodontic complications, 17.0 % for staff members and 25.4 % for workers.

Table 39.

Delivered therapy of different types. Numbers and means of procedures per individual during the initial treatment phase and numbers and means per individual per year during the maintenance phase.

Therapy	Staff Members (N=256)				Workers (N=186)			
	initial		maintenance		initial		maintenance	
	phase	%	phase	%	phase	%	phase	%
Total number of pro- cedures/individual	9.87		4.683		10.25		4.588	
Preventive care	5.3	53.7	3.24	69.2	4.4	42.9	3.15	68.7
Periodantal surgery	0.6	6.1	0.09	1.9	0.5	4.9	0.07	1.5
Amalgams	1.9	19.3	0.78	16.7	2.5	24.4	0.8	17.4
Composites	1.5	15.2	0.38	8.1	2.0	19.5	0.4	8.7
Root fillings	0.2	2.0	0.11	2.3	0.4	3.9	0.06	1.3
Crowns	0.2	2.0	0.06	1.3	0.2	1.9	0.07	1.5
Bridges	0.04	0.4	0.01	0.2	0.04	0.4	0.01	0.2
Partial dentures	0.08	0.8	0.007	0.1	0.16	1.6	0.019	0.4
Full dentures	0.05	0.5	0.006	0.1	0.05	0.5	0.009	0.2

Table 40.

Indications for extractions during the period
1974-1978. Number of extracted teeth for staff
members = 94 and for workers = 63.

	Staff Members	Workers
	%	%
Periodontitis	31.9	22.2
Periodontitis + caries	10.6	7.9
Periodontitis + endodontic complication	6.4	17.5
Length fracture	10.6	15.9
Partial impaction	23.4	14.3
Root remnant	8.5	6.3
Endodontic indication	4.3	9.5
Others	<u>4.3</u>	<u>6.3</u>
	100.0	100.0

DISCUSSION

Dental plaque

The plaque scores were assessed by the plaque control therapists as part of their routine clinical work. Therefore, the plaque scores for the individual subjects were often scored by different therapists. An evaluation of the inter-examiner variability at the end of the experimental period demonstrated a satisfactory reproducibility.

The plaque scores for the individual patient were approximated to the nearest 10 % level. This proved to be without disadvantage since the statistical method used was based upon distribution of frequencies at different plaque score levels.

During the clinical work the patients were encouraged to practice oral hygiene home-care effeciently enough to result in plaque scores of 20 % or less (which, due to the approximation of the plaque scores, corresponded to 24.4 % or less surfaces with plaque).

The patients accepted the 20 % score as a practical goal since it allowed failure of complete cleaning of some areas which motivated the selection of this level. Interdental oral hygiene aids are usually necessary to reach this level. Very few individuals out of a total of 2.500 patients 'so far treated in

the shipyard dental clinic have questioned the 20 % goal.

Most subjects had an unsatisfactory oral hygiene before treatment in 1974. This was confirmed by the progression of caries and periodontitis that occurred after the first examination 1965. Only 14 % of the staff members and 11 % of the workers had plaque scores $\leq$ 20 %. The level of oral hygiene was significantly improved one year after initial therapy and was maintained throughout the observation period. Approximately 70-75 % of the staff members and 55-60 % of the workers reached plaque scores $\leq$ 20 %. Separate studies on employees of the shipyard by Söderholm et al. (1979) and Söderholm & Egelberg (1979) have shown that improvement of oral hygiene takes place immediately following the plaque control instruction and that the reduced plaque scores can be maintained by a 3-months recall program. These studies also indicate that variations in the number of visits as well as teaching method for the primary plaque control instruction may be of less importance in a system which utilizes plaque score records for feed-back to the patients.

It is of interest to note that the mean plaque scores before experimental and during the maintenance phase of the present study agree closely with corresponding plaque scores in the study by Axelsson & Lindhe (1978).

Proximal calculus

An estimation of the most important epidemiological factor in periodontal disease, the viable subgingival plaque, is not possible to attain in epidemiologic work. Therefore it has been necessary to resort to assessment of the presence of calcified plaque. By this an evaluation of the efficiency of subgingival scaling, rootplaning and indirectly also of the periodontal conditions could be made (Lövdal et al. 1961).

The method employed has limitations as far as periodontal diagnosis is concerned. The degree of mineralisation of the plaque is of crucial importance to the roentgen diagnosis. Consequently, the initial mineralisation cannot be assessed by means of this technique. The anatomy of the proximal surfaces as well as the projectional conditions also contribute to the limitations of the diagnostic level. The calculus scores given obviously represent minimum values. The interpretations of the findings with respect to periodontal health or disease should be made with caution.

An inclusion of periodontal pocket depth as a clinical parameter was initially planned. Periodontal pockets were recorded by the auxiliaries as part of their routine procedures at each of the recall visits. Studies of the reproducibility of pocket measurements, however, demonstrated an unsatisfactory inter-

examiner reproducibility. The results of pocket measurements were therefore not used for scientific evaluation. Still, assessments of the pocket depth proved very useful in the clinical work as an instrument for feed-back.

An arbitrary level of 10 % proximal surfaces with calculus was set. This level corresponds to a maximum of four surfaces in a dentition with 32 teeth. Before treatment at the shipyard clinic, 24 % of staff members and 26 % of workers had calculus on <10 % of the proximal surfaces. At the end of the maintenance period the corresponding figures were 70 % for staff members and 77 % for workers. These percentages indicate that the treatment during the 1974-1978 period had a significant impact on the occurrence of proximal calculus and that the effect was of about the same degree in staff members and workers.

Overhanging restorations

Björn, Björn & Grkovic (1969) and Gilmore & Sheiham (1971) found a correlation between the presence of overhanging proximal restorations and loss of proximal periodontal bone support. The relation between overhangs and periodontal bone loss was found to be significant for overhangs ≥ 0.2 mm but not for overhangs <0.2 mm (Björn et al. 1969). This finding dictated the limitation of measurements of overhangs to those ≥ 0.2 mm in the present study.

The mean percentages of means per individual of proximal restorations with overhangs ≥ 0.2 mm before treatment in 1974 were 17.2 % and 17.6 % for staff members and workers respectively. These figures are lower than the findings by Björn et al. (1969) in their sample of patients seeking dental care in the School of Dentistry, Malmö, Sweden (about 35 %) and also lower than the findings by Gilmore & Sheiham (1971) studying a sample of a population in New Mexico, USA, (average 24 %). It is of interest to note that the frequency of overhangs in the present study was somewhat less in 1974 than in 1971. This together with the observation from Malmö 1969 indicate that more efforts had been made to avoid and to eliminate overhangs.

Removal of overhangs is often difficult. Overhangs of full crown restorations and overhangs deep into periodontal pockets may at times be impossible to eliminate completely. Such technical difficulties motivated the decision to use a level of 5 rather than 0 % restorations with overhangs as a basis for the statistical analyses.

Before treatment in 1974, 22 % of staff members and 36 % of workers had < 5 % restorations with overhangs ≥ 0.2 mm. At the end of the observation period the corresponding figures were 73 % for staff members and 80 % for workers. For large overhangs (≥ 0.4 mm) 54 % of staff members and 67 % of workers had < 5 %

overhanging restorations before treatment, and at the end of the observation period the figures were 95 % and 99 %. These results indicate that the therapy provided during the 1974-1978 period was quite successful in reducing overhangs.

Periodontal bone height

The periodontal bone height was measured from panoramic roentgenographs of mandibular premolars and molars. Björn et al. (1975) found a close correlation between the periodontal bone heights determined from intra-oral roentgenographs of the full dentition and the bone heights measured from the mandibular premolar and molar region only. This means that, with respect to bone height, the full dentition may be represented by the mandibular posterior teeth.

The structural details of the mandibular premolar and molar regions in panoramic roentgenographs are usually adequately depicted. A high degree of reproducibility of the bone height measurements was documented in this study. Thus, within the limitations of the use of roentgenographs of a selected area of the dentition, bone height determinations ought to provide a satisfactory method to assess changes of the periodontal bone support.

Significant loss of periodontal bone was found for staff members and workers during the 1965-1971 interval as well as during the 1971-1974 period. No further loss of bone took place during the 1974-1978 interval. In fact a slight increase was observed. This may to some degree be an effect of an increased calcification of the marginal bone due to a healing process.

The number of lost premolars and molars was less during the 1974-1978 period than during the 1971-1974 interval. Therefore, it is less likely that extraction of a high number of periodontally severely involved teeth during the 1974-1978 period was the cause of the satisfactory average bone height of the remaining teeth in 1978. It is noteworthy in this connection that bone height was measured adjacent to the same teeth throughout the observation period.

The fact that the successive periodontal breakdown during the 1965-1974 period was arrested during the 1974-1978 interval does not mean that the bone level was preserved in all examined teeth in all individuals. On the whole, progression was, however, arrested within the studied population. Similar results have been reported by Suomi et al. (1971), Ramfjord et al. (1975), Lindhe & Nyman (1975) and Axelsson & Lindhe (1978).

Proximal caries increment

In order to overcome as far as possible the difficulties inherent in roentgenographic caries diagnosis (Gröndal 1979), new caries was recorded only in tooth surfaces that at the previous examination were judged free of caries. Thus the diagnosis new caries always was made against the background of retrospective comparisons of identical tooth surfaces. Determinations of new carious lesions from the bite-wing roentgenographs could be made with a satisfactory reproducibility.

The development of new carious lesions during the pre-experimental period was determined by comparisons of roentgenographs from 1971 and 1974. The analysis of caries data from the experimental period was facilitated by the presence of a full series of bite-wing roentgenographs from each patient, viz. before treatment in 1974, immediately after initial treatment in 1974 and yearly during the maintenance phase. The fact that the 1971-1974 period was shorter than the experimental period means that more carious lesions could be expected during the latter. The results of the study demonstrated, however, that the incidence of proximal roentgenographic caries was significantly lower during the 1974-1978 interval than during the 1971-1974 period.

During the 1971-1974 period 36 % of staff members and 37 % of workers did not develop proximal carious lesions. The corresponding figures during the 1974-1978 interval were 63 % for staff members and 56 % for workers. During the experimental period the mean number of carious lesions per individual per year (0.2) was less than half of that during the pre-experimental period (0.4). These figures indicate that the combined therapy provided during the experimental period, including plaque control efforts and topical fluoride applications, resulted in decrease of proximal caries.

The decrease of the number of proximal carious lesions in the present study was less than that observed by Axelsson & Lindhe (1978). The reasons for this discrepancy can only be speculated upon. The populations were of course quite different. Among other things they probably differed in dietary and dental care habits. Further Axelsson & Lindhe made use of more frequent recalls during the first two years (every second months).

Tooth mortality

In the oldest age groups the number of individuals without tooth loss was significantly higher during the experimental than during the 1971-1974 pre-experimental interval.

Teeth extracted during the initial treatment phase were included in the 1974-1978 data. Considering that the observation period was limited to 3-4 years it may still be argued that the reduced tooth mortality during the 1974-1978 period was an effect of restrictive attitude to extractions rather than to improved dental conditions. However, several of the parameters of the present study indicate that the dental state of the remaining teeth had improved from 1974. This seems to contradict the possibility that the reduction of tooth mortality during the 1974-1978 period was related to an increased tendency towards preservation of questionable teeth. However, periods of 3-4 years may be too short to permit definite conclusions from tooth mortality data.

Delivered therapy

The amounts and types of therapy delivered to the employees were estimated from clinical records. Accordingly, the scope was limited by the record system which was based on the standards laid down by the Swedish National Social Insurance Board.

The amount of therapy provided during each of the maintenance years was less than that during the initial treatment phase. Of special interest are the numbers of amalgam, composite and full crown restorations. During the maintenance phase an average of only 1.2 restorations per year was required compared to an

averages of 3.6 - 4.7 restorations during the initial treatment phase.

In order to evaluate the indications for restorations a separate study was made during 1978-1979. This included all employees of the shipyard under maintenance care. The indications were recorded for a total of 935 consecutive restorations inserted during a period of 11 months. Fifty-nine per cent of these restorations were made because of fractures or technical deficiencies of pre-existing restorations, while 41 % were placed because of caries (see table 41). The combination of the information from this study with the data from the main investigation, suggests that the average employee under maintenance care probably required about one restoration every second year to restore lesions caused by caries.

Concluding remarks

The present study was performed in patients provided with dental care under routine clinical conditions. The subjects were part of a larger patient pool given the same type of care in the shipyard dental clinic and they were not given special attention. In these respects, the subjects could be considered representative of "the average dental patient" in the clinic. From two other aspects, however, the conditions around this study may deviate from the "average environment". The sub-

Table 41.

Percentage distribution of caries and technical failures as indications for placement during an 11-month period 1978-1979. Different types of restorations in employees under maintenance care. N = number of restorations.

Indication	Amalgams	Composites	Full crowns
	N=647	N=262	N=26
Caries	47	25	19
Technical	53	75	81

jects were staff members and workers employed by the factory for a minimum of 13 years. These employees may constitute a relatively "solid" type of individuals.

One of the advantages of a dental clinic located within an industrial estate is that individuals previously being sporadic dental visitors could be recruited to a maintenance program with frequent recalls (see table 4).

The income of the dental personnel was not based on a bonus system. This probably furthered the efforts towards preventive measures. If this assumption is valid the present dental care delivery system in Sweden, governed by the National Social Insurance and based primarily on fee per item of service, may be one of the factors impeding a preventive type of care.

Statistics available from the Swedish National Social Insurance Board (Sundberg & Eriksen 1976, Markén & Blendow 1979) indicates that preventive measures constitute less than 10 % of the therapy delivered to the Swedish population and that restorative and prosthodontic measures add up to about 75 % of the care. Comparisons between this statistics and the data from the present study are difficult to make because of the different basis for computation. There seems to be little doubt, however, that the need for restorative and prosthodontic treatment in the shipyard patients

was less than the average for the Swedish dental patients and that this most likely is explained by differences in emphasis on preventive care.

The three months recall intervals during the maintenance program were based upon successful results of previous studies using this recall frequency to prevent progression of periodontal disease (Suomi et al. 1971, Ramfjord et al. 1975, Knowles et al. 1979). It was anticipated that recalls every third month would be an acceptable frequency for the patients. During the course of the study it became clear that practically all patients felt comfortable with this recall routine. The delivery of the preventive treatment by auxiliaries without direct participation of a dentist was also accepted.

The clinical parameters used in the present study do not permit conclusions about the complete dental health of the subjects. The main part of investigation does not comprise the total dentition. Nevertheless, the results indicate that the dental care program significantly improved the dental health and that the increased time and efforts devoted to preventive care were compensated by a decreased need for restorative treatment.

The participants in the present study suffered already at the start from more or less advanced dental disease which admittedly had

progressed during eight years of pre-experimental observation. Consequently, the preventive measures were started during a period characterized by active caries and periodontitis. The results obtained warrant the conclusion that it is possible also in adults with active disease to arrest or slow down further progression by the type of dental care delivered at the Kockums Shipyard.

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